A Primer on Chamber Pressure Anomalies, Part 1





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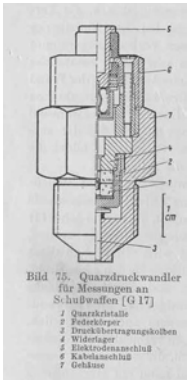
Historical Perspective



Gage used by Oerlikon Buhrle in 1935 described by Dr. Werner Gohlke in 1959

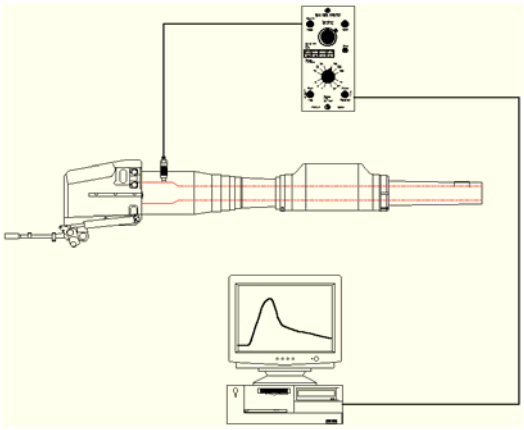
Watermelon Tourmaline

Quartz

Black Tourmaline

- Piezoelectric effect discovered by Jacque and Pierre Curie in 1883.
- Early Piezoelectric sensors were coupled to Electrometer Amplifiers
- Charge Amplifiers developed in the 1950s eliminated the need to measure capacitance in individual cables.
- Quartz pursued by private industry while Tourmaline was pursued by US Military.

Pressure Measurement Today



Equipment consists of Transducer, Charge Amplifier and a means to read voltage output of Charge Amplifier

US Army Model E30MA

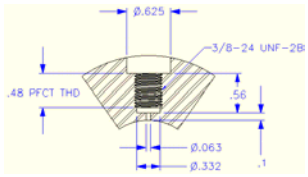
ITOP 3-2-810 Requirements

Devices for Measuring	Measurement Accuracy
Range	0 - 1000 MPa
Insulation resistance	$\geq 5 \times 10^{13}$ Ohm (desired)
	$\geq 10^{12}$ Ohm (required)
Natural frequency	$\geq$150 kHz
Linearity	$\pm$1% of full scale output (FSO)
Shock resistance	$\geq$100,000 m/sec^2
Calibration factor repeatability	$\pm$0.5%
cycle to cycle	$\pm$2%
calibration to calibration lifetime	$\pm$5%
Operating temperature	-50°C - +200°C

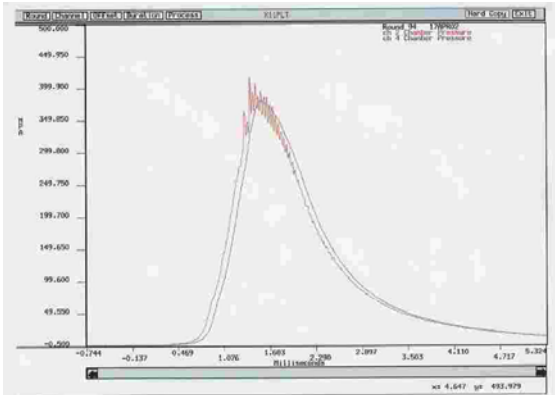
Note that Calibration Repeatability is tighter than Full Scale Linearity

Helmholz Resonance

Kistler Model 607

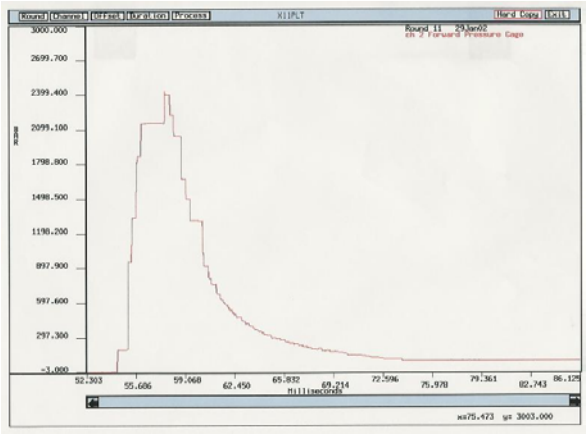


Mann Barrel Pressure Port



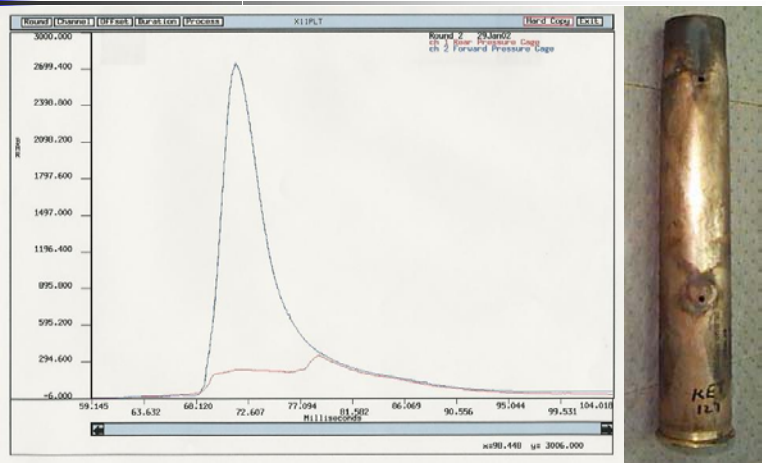
Original trace alongside 5 kHz filtered trace

Cable Whip Induced Signal Breakup



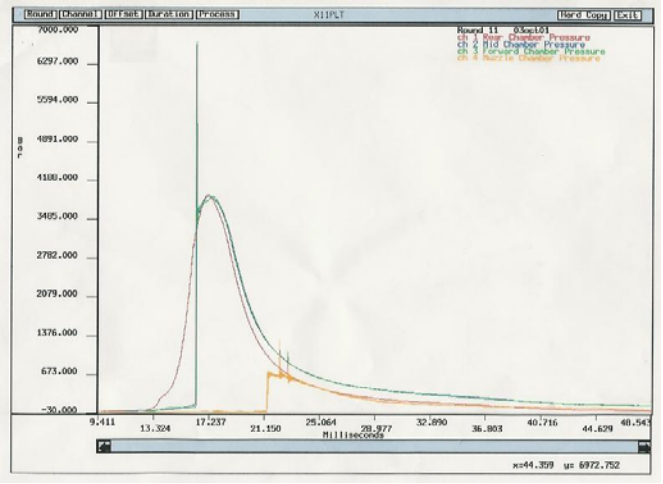
Typical "Stair-step" curve resulting from momentary signal loss over Microdot Cable

Cartridge Case Misalignment or Improper Drilling



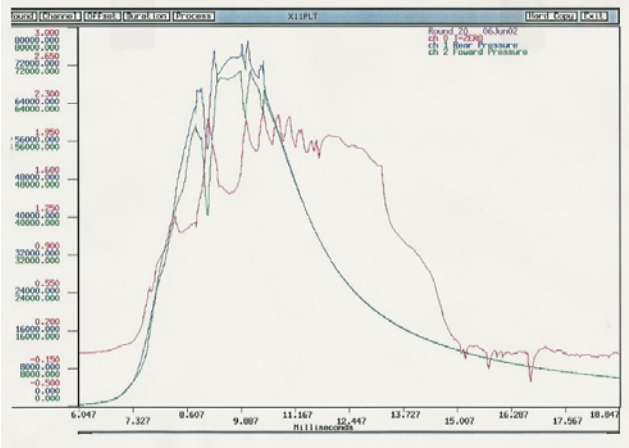
Cartridge Case ported for pressure measurement. Rear hole is not aligned with forward hole.

Absence of Cartridge Case Drilling



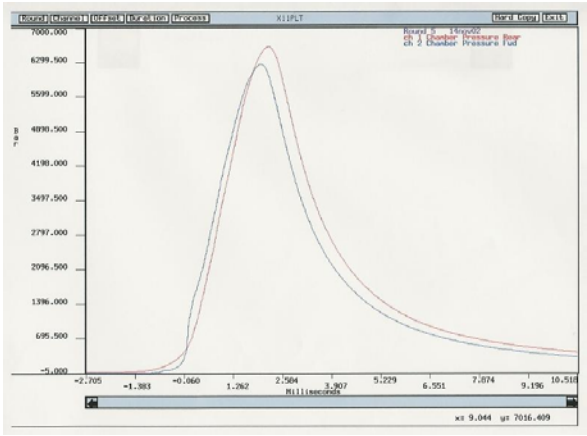
Cartridge Case material impacts pressure sensor.

Electrical Artifacts in Pressure Traces



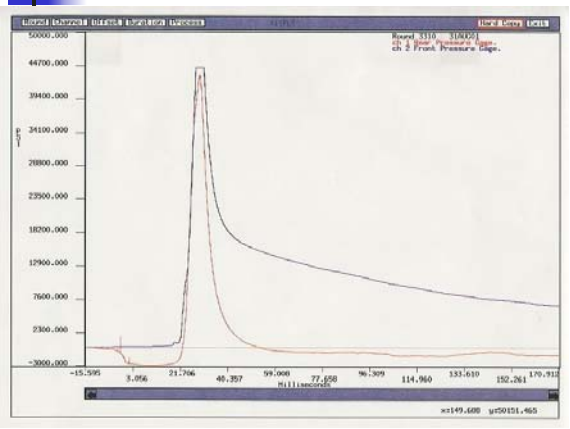
Data dropouts were found to be electrical in nature after the firing pulse curve was superimposed over pressure curves. Problem was rectified by improved grounding of the firing circuit.

Software Induced Excessive Negative Differential Pressure

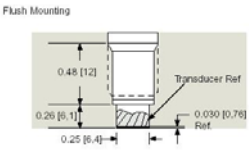


With both channels set as Masters, separate T-Zeros were recorded. The plotting routine, aligned the separate T-Zeros and created the illusion of excessive Negative Differential Pressure.

Pressure Reversal Induced by Blowby



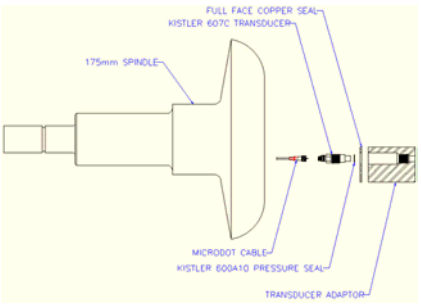
Kistler Model 607



Lower than expected rear pressure caused by inadequate pressure sealing behind the adaptor containing the transducer.

Pressure Reversal Induced by Blowby (Cont.)

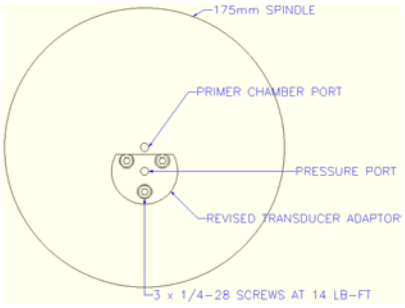
Image of Spindle with Adaptor Block below Flash Hole.



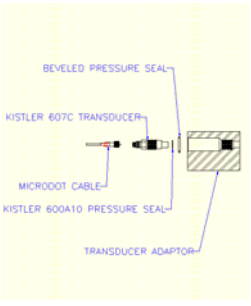
General Arrangement of Spindle, Transducer, Pressure Seal and Adaptor Block. Adaptor Block was held in place by two ¼-28 Screws, Hand Tightened.

Pressure Reversal Induced by Blowby (Cont.)

Proposed Improvements:



New Adaptor Block designed for three Mounting Screws torqued to 14 lb-ft.



Pressure Seal with smaller surface area for greater compression.

Conclusions

- The majority of Chamber Pressure Measurements can be accomplished with little or no difficulty.
- Application of Root Cause Analysis can identify the cause of discrepant behavior.
- Other occurrences cannot be readily explained by the examples contained herein but with time and determination their causes can be identified.